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ABSTRACT

The Connecticut Science Teachers Association has identified science competencies for students completing grades 4, 8 and 12 in Connecticut schools for use by school districts as a guide for curriculum assessment and development. This list is not to be used as an instrument for testing and evaluation but should provide a reference for competency-based teaching. Concept objectives in physical science and life science are outlined for the three grade levels, along with student skill objectives and student attitudinal objectives. Grade twelve information also includes concept objectives in earth science. (Author/DS)

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Suggested Science Competencies For Students Completing Grades 4, 8 and 12 In Connecticut Schools

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The Connecticut Science Teachers Association
May 1980

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HISTORY OF CHARGE

Early in 1976, the Connecticut Education Forum (CEF) asked the Connecticut Science Teachers Association (CSTA) to explore the possibility of identifying competencies in science for students in Connecticut schools. As CSTA's representative to the CEF and as President of CSTA at that time, Sarah Beth Klein accepted the challenge of undertaking such a task. Finally, after several unsuccessful beginnings, a chairperson was selected in the fall of 1976, a committee was formed, a model format was designed, and a procedural plan was implemented.

Many meetings were held throughout the 1976-'77 academic year to identify competencies for youngsters ages 9, 13, and 17 in keeping with the categories established by the National Science Assessment and the Connecticut Science Assessment teams. Competencies were defined as "knowledge," "skills," and "attitudes." No judgment was made on the desirable degree of progress (level of proficiency) toward the attainment of the competencies.

The committee considered the appropriateness of the concepts, skills, and attitudes for each age group by reviewing theories of learning and research in educational psychology. Published and unpublished curriculum documents collected from around the country were examined and current trends were identified. Cognizant of the potential impact a state level document on science competencies could have in determining the direction of science education in Connecticut and, in part, throughout the nation, the committee accepted its responsibility seriously and proceeded cautiously toward accomplishing the assigned task.

Whenever possible, the committee held meetings to encourage contributions from other interested persons. To obtain agreement was a struggle but, eventually, the committee was able to write a first draft document by the fall of 1977.

On September 14, 1977, the draft was presented to the Executive Board of CSTA for reactions. On September 15, 1977 it was delivered to CEF for comments. The committee reconvened on November 2, 1977 to consider suggestions made by both groups to revise the first draft document.

The second draft stated that the competencies were for students in grades 4, 8, and 12. The competencies represented those the committee believed were reasonable to expect of the majority of students in the state. They were considered to be needed for students to function successfully in society. It should be made clear that even in the final revision, the objectives do not represent minimum competencies nor are they considered to be the ultimate goals.

The second draft document was discussed at CEF's annual conference in November, 1977, at the NSTA regional convention held in Boston in December, 1977 and at CSTA's twenty-fifth anniversary meeting in January, 1978. Comments from the participants were reflected in the third draft document. Since then a fourth draft document was presented at the NSTA National convention in Washington, D.C. in April. That, too, was revised and a fifth draft was sent to CSTA members in the fall 1978.

Members of the CSTA were asked to rank the objectives according to impor-

tance and to indicate if they were "essential," "important," "optional" or "inappropriate." They were also asked to add and delete items and to write comments. Results of the surveys were reviewed by the committee in November 1978. Throughout the following three months, committee members assimilated the changes reflected by the membership into the sixth revision.

On March 13, 1979, the committee met to edit the sixth draft. The publication as it is now presented is the seventh and final revision.

COMMENTS AND RECOMMENDATIONS

It is important to note that most science educators in the State of Connecticut would support a process approach to learning science. However, by their nature, competency statements often appear to be primarily content oriented. Both process and content should be intertwined in learning science and the competency statements herein should be viewed from that perspective.

The objectives that follow are listed in order of importance as identified by a poll of the Connecticut science teachers. They are not listed in a suggested teaching sequence nor are the preceding or subsequent objectives necessarily related.

Although there is no particular stress placed upon the importance of using the metric system throughout the document, the committees recommend that the SI metric system of measurement be used as much as possible.

The Connecticut Science Competencies Committee also recommend that the Suggested Science Competencies for Students Completing Grades 4, 8, and 12 in Connecticut Schools in its final, though tentative form, be viewed by school districts of the state solely as a guide for curriculum assessment and development and that it not be used as an instrument for testing and evaluation. The document should provide a frame of reference for competency based teaching and not be confused with competency based testing.

Bette J. DelGiorno
Chairperson
March 15, 1979

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SUGGESTED SCIENCE COMPETENCIES FOR STUDENTS COMPLETING GRADE 4

CONCEPT OBJECTIVES IN SCIENCE

Concept Objectives in Life Science

Concept: Living things respire, need nourishment and water, and reproduce their own kind.

1. List at least three requirements for growth of all green plants.
2. List functions that distinguish living organisms from non-living things and things no longer alive.
3. Indicate changes that take place in each season of the year.
4. Describe the function of the skeleton in terms of protection and support for animals with and without backbones.
5. Give at least one example of how plants have adapted to their environment.
6. Construct three simple food chains including one involving the human being.
7. Identify, in sequential order, pictures of stages in the life history (cycle) of common animals.
8. Explain the role of blood, blood vessels, and the heart in circulating food and oxygen to all parts of the body and in removing wastes from body cells.
9. Identify, in sequential order, pictures of stages in the life history (cycle) of human beings.
10. Explain how a human brings oxygen into its body.
11. List at least three factors that limit the number of plants and animals surviving in each generation.
12. Arrange, in sequential order, pictures of stages in the life cycle of a common plant; e.g., bean, dandelion.

Concept Objectives in Physical Science

Concept: The physical world consists of matter and energy interacting.

1. Identify from a collection of substances those which are solids, liquids or gases.
2. Cite evidence that heat, light, and electricity are forms of energy.
3. Furnish at least one kind of evidence indicating the presence of air.
4. Locate the relative position of the sun, earth, and moon in our solar system and indicate awareness of seasons and also moon phases.
5. Identify, from a group of given objects, those which are good or poor conductors of electricity.
6. Name materials that magnets attract.
7. Identify, from a group of materials, those which are good or poor conductors of heat.
8. Describe a change that takes place as the result of a common chemical

reaction; e.g., vinegar and baking soda, iodine and starch.

SKILL OBJECTIVES IN SCIENCE

Cognitive***Process***Psychomotor

1. Measure length to the nearest scale gradation.
2. Read a thermometer to the nearest gaduation.
3. Collect and record data from experiments and activities.
4. Use a hand lens to observe detail not easily distinguishable to the naked eye.
5. Identify and classify objects using odor, taste, touch, sound and sight.
6. Make predictions and verify accuracy; e.g., do seeds germinate better in light or dark?
7. Weigh oneself to the nearest graduation on the scale.
8. Classify animals and plants based on the likenesses and differences that exist among them; e.g., structure, habitat; etc.
9. Operate a beam balance (seesaw).
10. Sort and group objects by their properties.
11. Make simple quantitative estimates and verify them; e.g., estimate the number of beans in a jar.
12. Make sketches from observations.
13. Identify those factors which must be kept constant during an investigation.
14. Demonstrate skill in feeding and caring for a living animal over a period of time.
15. Demonstrate skill in propagating plants and caring for them over a period of time.
16. Make a simple electric circuit, given a wire, bulb, and battery.

ATTITUDINAL OBJECTIVES IN SCIENCE

Affective

1. Demonstrate the value of following the rules of safety.
2. Exhibit self-confidence through the study of science by being involved in a variety of scientific activities.
3. Accept evidence gathered through scientific methods.
4. Demonstrate individual curiosity and persistence in the study of science.

SUGGESTED SCIENCE COMPETENCIES FOR STUDENTS COMPLETING GRADE 8

CONCEPT OBJECTIVES IN SCIENCE

Concept Objectives in Life Science

Concept 1: Living organisms carry on life functions.

1. Illustrate that living organisms have life cycles; e.g., birth to death, seed to mature plant.
2. Distinguish between living and non-living things by describing life functions.
3. Discuss health as the absence of disease.
4. Show that disease may be prevented by good habits of eating, resting, exercising, and hygiene.
5. Describe the differences in the structure and function of cells, tissues, and organs.
6. Find patterns in data, events, and life itself.
7. Explain the process of photosynthesis and its dependence upon such factors as light energy, chlorophyll, water, and carbon dioxide.
8. Explain how "like tends to beget like," (genetics) there is a probability in the prediction of future organisms by knowing their ancestors.

Concept 2: Living organisms and their environment are interdependent and are constantly interacting.

1. Illustrate and describe the water cycle.
2. Explain the predator-prey relationship.
3. Give reasons for the need to conserve soil.
4. Compare, contrast, and discuss food chains and food webs.
5. Define symbiosis and give examples of this relationship.
6. Explain the carbon-hydrogen-oxygen cycle.
7. Describe the nitrogen cycle.
8. Explain what soils are and how they are formed.

Concept Objectives in Physical Science

Concept: The physical world consists of the interactions of matter and energy.

1. Give examples of different forms of energy.
2. Identify the three basic parts of an atom, their charges and relative locations.
3. Give examples of chemical changes, e.g. rusting of iron.

4. Differentiate among solids, liquids, and gases, and describe their properties by using the kinetic molecular theory.

5. Relate how an energy change is involved whenever there is a change in the state (phase) of matter; e.g., water to steam, etc.,

6. Describe how forms of energy may be changed into other forms of energy.

7. Define a calorie and differentiate between small and large calories.

8. Demonstrate an awareness that atomic energy results from the conversion of nuclear mass into energy.

9. Identify sources of nuclear energy and compare fission and fusion.

10. Differentiate among and give examples of the following forces: adhesion, cohesion, capillarity, surface tension, gravity and friction.

11. Explain some of the factors which affect electricity as a flow of electrons.

12. Explain the relationship of temperature to the kinetic molecular theory.

13. Define and illustrate the difference between kinetic and potential energy.

14. Describe patterns in the Periodic Chart of the Elements.

15. Explain that density is the relationship between mass and volume.

16. Define and distinguish between mass and weight, and between mass and volume.

17. Explain how electrical energy can be used to operate devices such as the radio, telephone, computer, etc.

SKILL OBJECTIVES IN SCIENCE

Cognitive***Process***Psychomotor

1. Use measuring devices and record data properly.

2. Make graphs and charts from the data given.

3. Interpret data, charts, and graphs, and make generalizations.

4. Follow directions to utilize simple tests and interpret results.

5. Employ mathematics necessary to convert units within the metric system.

6. Develop an hypothesis from basic data and devise a method to test it.

7. Use, maintain, and care for laboratory equipment.

8. Distinguish between qualitative and quantitative observations.

9. Follow laboratory safety rules at all times.

10. Use "scientific methods" for setting up an experiment which has controls and variables.

11. Communicate information organized in logical sequences orally and graphically using related vocabularies.

12. Recognize that certain teaching devices, such as a "model," are only aids and are not reality.

13. Apply scientific theories and laws to a given situation.

ATTITUDINAL OBJECTIVES IN SCIENCE

Affective

1. Follow the rules of safety in the science laboratory.
2. Appreciate that science is a way of looking at the universe, at life, and is a part of life.
3. Show respect and appreciation for all living organisms.
4. Appreciate how science is related to one's world.
5. Respect and appreciate the environment based on knowledge.
6. Appreciate the value of critical thinking.
7. Appreciate the value of scientific instruments as extensions of the senses.

SUGGESTED SCIENCE COMPETENCIES FOR STUDENTS COMPLETING GRADE 12

CONCEPT OBJECTIVES IN SCIENCE

Concept Objectives in Life Science

Concept 1: All living thngs have basic needs.

1. Discuss the fact that living things must have water and nourishment, respire, and reproduce to continue the species.
2. Discuss the proper care of laboratory animals and treatment of domestic animals and wildlife.
3. Discuss the proper care of plants in the laboratory, greenhouse, at home, out-of-doors and the importance of preserving wildflowers, plants, bushes, and trees.

Concept 2: Knowledge of the dynamics of ecology is essential for intelligent planning and decision making.

1. Define an ecosystem and compare biotic and abiotic factors.
2. Describe adaptations of organisms for survival in a particular ecosystem.
3. Identify and describe a predator-prey relationship.

Concept 3: Living things require energy and there must be an interchange of energy in a balanced environment if living things are to survive.

1. Explain the relationship between producers, consumers, and decomposers.
2. Compare and contrast photosynthesis and cell respiration.
3. Explain the relationship between a food chain and a food web.

Concept 4: The cell is the basic structural and functional unit of most living things.

1. Explain the relationship between cells, tissues, organs, and systems.
2. Make comparisons between plant and animal cells.
3. Identify the organelles of the cell and explain their functions.
4. Compare and contrast mitosis and meiosis and explain the purpose of these processes.

Concept 5: A pattern of inheritance can be observed over a period of time.

1. Explain the difference between asexual and sexual reproduction.
2. Illustrate the Mendelian Laws of Inheritance.
3. Describe the chemical nature of genes and chromosomes and their role in maintaining genetic continuity.
4. Discuss the benefits and dangers of genetic engineering.

Concept 6: Correct information about the human body will aid the individual in daily life and make one a more efficient and responsible human.

1. Explain the structure and function of human body systems.

2. Discuss the following as they relate to health:

   a. human growth and development
   b. hygiene
   c. drugs, alcohol, and nicotine
   d. nutrition
   e. food additives and imitation foods.

Concept 7: Some microorganisms cause disease and others are beneficial.

1. Discuss the role of bacteria in health and disease.

2. Explain the methods by which pathogenic organisms can be transmitted.

3. Explain active immunity and how it is acquired.

4. Explain passive immunity and how it is acquired.

5. Compare and contrast bacteria, viruses, fungi, and molds.

Concept 8: There is an increasing order of complexity in living organisms.

1. Select two animals from different phyla and compare structures and how the animals carry on life functions.

2. Select two plants ranging from algae to angiosperms and compare structure and how the plants carry on life functions.

Concept Objectives in Physical Science

Concept 1: Matter is composed of molecules, atoms, or ions whose interactions, when observed and measured, are found to follow natural laws.

1. Distinguish between atoms and molecules.

2. Distinguish among elements, compounds, and mixtures.

3. Identify the physical state(phase) of a substance.

4. Locate protons, neutrons, and electrons in the present model of the atom and state the charge of each.

5. Describe how molecules are composed of atoms bonded together.

6. Substantiate that chemical reactions result in new substances with new properties.

7. Explain why and how in ordinary chemical reactions, the total mass of reactants must equal the total mass of products.

8. Describe general properties of acids, bases (alkalis), and salts and describe neutralization.

9. Compare and contrast a physical and chemical change.

10. Explain how an ion is a charged partical and an atom is a neutral particle.

11. Identify the solute and solvent in a solution.

12. Explain the relationship between atomic structure and the properties of the elements.

13. Identify the symbols of "common" elements.

14. Distinguish between simple organic compounds and inorganic compounds.

Concept 2: Energy exists in many forms which are interconvertible through reactions with matter.

1. Differentiate between situations illustrating kinetic energy and potential energy.
2. Explain the affect of temperature on the physical state (phase) of a substance.
3. Substantiate that chemical reactions are accompanied by energy changes.
4. Explain the difference between temperature and heat.
5. Predict the affect of a temperature change and of pressure change on the volume of a gas.
6. Explain the relationship between molecular motion and temperature.
7. Explain the relationship between molecular motion and pressure.
8. Define what is meant by a gas, liquid, and solid in terms of the proximity and relative motion of their particles and in terms of their size and shape.
9. Define work and do simple problems involving work.
10. Define velocity and speed.
11. Define and give examples of forces.
12. Describe the factors that influence the rate of a chemical reaction.
13. Explain the phase changes associated with the melting point and with the boiling point of a substance.
14. Define electricity.
15. Explain the ways in which static electricity, Alternating Current (AC) and Direct Current (DC) differ.
16. Cite evidence that, under ordinary circumstances, matter and energy can be converted from one form to another with no loss or gain.
17. Explain how simple machines operate.
18. Define acceleration.
19. Explain the relationship between the quantity of material and the heat content of the substance.
20. Define friction and give examples of its advantages and disadvantages.
21. Cite evidence that matter and energy are interconvertible but the sum total of these remains constant.
22. Describe sound and explain it as a form of energy.
23. Discuss the electromagnetic spectrum.
24. Explain electromagnetic radiation as a form of energy.
25. Explain the operation of semiconductors and list some uses.
26. Contrast nuclear fission and fusion.

Concept Objectives in Earth Science

Concept: Earth Science is the study of the nature of matter and energy through earth processes.

1. Define the study of astronomy as relating to galaxies, star systems, and space.
2. Illustrate that geology concerns itself

with historical geology, the story in the rocks, earth chemistry, and the restless earth.

3. Discuss the limits of the earth's energy resources.

4. Recognize and identify general land forms.

5. Recognize the dynamic nature of the earth.

6. Explain how oceanography concerns itself with salinity of oceans, marine biology, marine topography, and motions of tides, waves, currents and shorelines.

7. Discuss how meteorology is concerned with weather, air and its movements, chemical and physical properties of gasses, air masses, motion caused by the sun's energy, weather maps, and forecasting.

8. Discuss the energy source for earthquakes, thunderstorms, ocean currents, and starlight.

9. Illustrate and explain the rock cycle.

10. Make some predictions concerning the geological future.

SKILL OBJECTIVES IN SCIENCE

Cognitive***Process***Psychomotor

1. Interpret results.

2. Set up controls or standards.

3. Communicate acquired knowledge graphically, quantitatively, and verbally.

4. Use the specific vocabulary related to each topic under study.

5. Demonstrate skill in the use of appropriate techniques, instruments, equipment and test kits within each discipline as required.

6. Select and assemble appropriate equipment and conduct experiments.

7. Make the necessary observations and record the data in an appropriate and logical format.

8. Consider alternative solutions.

9. Identify a problem and state it clearly.

10. Examine the literature for ideas related to the problem.

11. Design experiments and define variables.

ATTITUDINAL OBJECTIVES

Affective

1. Be aware of the importance of biology as a study of living things and how it relates to oneself.

2. Develop appreciation for critical thinking as used in the practice of science.

3. Demonstrate a willingness to cooperate in class and laboratory.

4. Appreciate that one's genetic characteristics and environmental factors work together to comprise the individual's total being.

5. Develop attitudes that are build upon fact and logic.

6. Show satisfaction when accomplishing something worthwhile.

7. Demonstrate a better understanding of the advantages and problems created in the everyday world by society's use and misuse of scientific knowledge.

8. Appreciate the potential for careers in the sciences and science related fields.

9. Observe rules of safety in the laboratory and field.

10. Demonstrate a belief that the physical universe obeys specific laws.

11. Appreciate the relationship of concepts studied to the everyday world.

12. Demonstrate the development of a personal value system regarding the environment by willingness to adjust one's life style to be in harmony with ecological laws.

13. Appreciate and visualize the space-time relationships associated with earth and the universe.

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